AIRBORNE CONTAMINATION IN DENTISTRY

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At the close of the second millennium, the invisible world of the microorganisms responsible for infection was progressively revealed. Each discovery was accompanied by new technologies and practices were designed to limit the transmission of infection in the medical environment. The adoption of best practices, such as the use of gloves and masks, sterilization and disinfection procedures has succeeded in reducing infection by fluid transfer and contact. More recently, the threat of infection from water has been identified and effective solutions have been devised.

Today, attention is turning toward the last and most elusive means of pathogen transmission – the air. The hypothesis of the aerobiological transmission of infection dates back to 1720 when an English physician, Benjamin Marten, suggested the possibility of contracting tuberculosis by breathing the air of a patient infected with the disease. Towards the end of the 20th century, armed with evolving knowledge and measurement techniques, aerobiological infection became the subject of renewed interest. The role of the air as a carrier of infection was confirmed in scientific studies focusing on the transmission of tuberculosis in aircraft and transmission of measles in a paediatrician's office.

The recent epidemics of the severe acute respiratory syndrome (SARS) and multi-resistant Staphylococcus aureus (MRSA), and the substantial mortality each year from influenza bring the importance of aerobiological bacterial and viral infection transmission into sharp relief.

How does it start?

The chain of aerobiological infection begins with the dispersion into the air of bacteria and viruses. The principle source of such contamination is the mouth with saliva, blood, subgingival fluids and moisture from the nasopharynx constituting the largest reservoir of infectious organisms. These fluids are projected into the air by coughing, sneezing and general exhalation. In a dental surgery, however, this process is exacerbated significantly by the use of the high-speed instruments such as ultrasonic scalers and drills (Figures 1 and 2).

During treatment, several thousand droplets are aerosolized. Whereas the larger droplets fall quickly to the floor and on to other surfaces, the smaller droplets evaporate quickly, leaving dry microscopic droplet nuclei. These are so small that they can remain suspended in the air for extended periods of time. In a calm room, for example, a droplet of 2 microns in diameter requires an average of 4.2 hours to settle.

Additionally, bacterial and viral microorganisms are transported on the squamae that are continually exfoliated from our skin. One study revealed that an average human being liberates approximately 310 squamae per day. Researchers now believe that the majority of Staphylococcus aureus, one of the leading causes of hospital acquired infection, is transported mainly on these skin squamae – being readily disturbed from floors and other surfaces as microscopic specks of dust but upon which thousands of pathogens are continuously hitching a ride.

Once in the air, the bacteria and viruses become highly mobile. They circulate from one room to another by convection

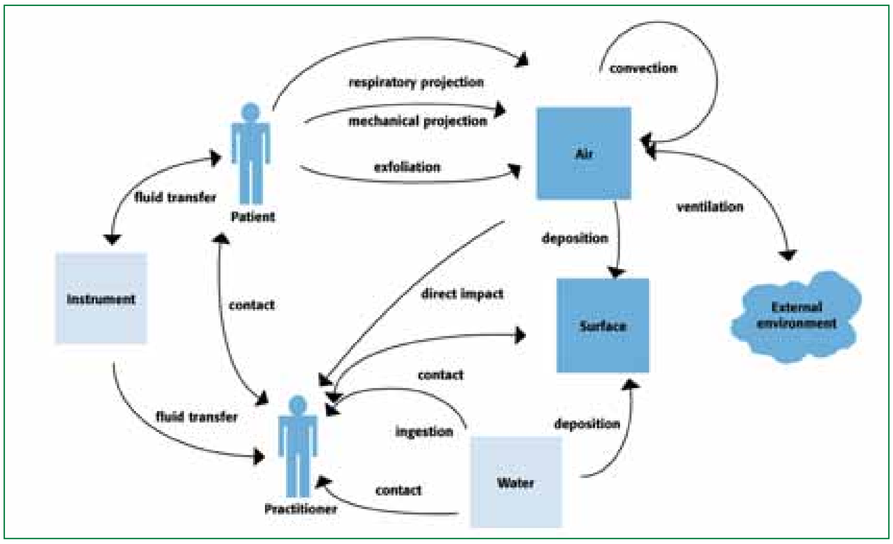

Figure 1: Transmission of pathogens in a dental surgery.

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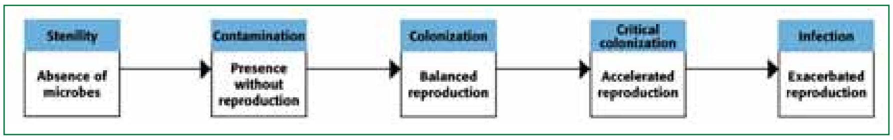

Figure 2. The progression of infection.

currents often provoked by the movement of people. If your surgery is equipped with an air conditioning or a ventilation system, or if you simply open your window, the microorganisms are rapidly spread - often lifting from surfaces where they have previously settled and floating freely around the surgery and into other practice rooms. In this state the microorganisms will also deposit on to your clothing, your instruments and the working surfaces of your surgery. As a result of the droplets and the dust-borne microorganisms, dental patients and dental health care workers may be exposed to a variety of microorganisms - via blood, oral or respiratory secretions. Such pathogens may include Cytomegalovirus, hepatitis B virus, hepatitis C virus, herpes simplex virus types 1 and 2, human immunodeficiency virus (HIV), Mycobacterium tuberculosis, Staphylococci, Streptococci, and other viruses and bacteria (see Box 1).

Infections may be transmitted in the dental surgery through several routes, including direct contact with blood, oral fluids, or other secretions; through indirect contact with contaminated instruments, surgical equipment, or environmental surfaces or through contact with aerobiological contaminants present in either droplet spatter or the aerosols resulting from oral and respiratory fluids.

Infection via any of these routes does, however, require that all three of the following conditions be present – these being commonly referred to as key components in ‘the chain of infection’:

- A susceptible host
- A pathogen with sufficient infectivity and in sufficient numbers to cause an infection
- A point of entry into the host.

Effective infection-control strategies are intended to break one or more of these ‘links’ in the chain, thereby preventing infection. The consequences of contaminated air are the source of numerous recommendations by American and European dental authorities concerned with cross infection. These include:

- The reduction of movement by personnel
- A separate gowning room for clothing worn outside the surgery
- The wrapping of instruments after sterilization
- The regular disinfection of surfaces.

All surgical procedures, particularly dental implantation, involve certain infection risk factors. One of the most common is that of postoperative infection. The harsh realities of today’s medical environment, e.g. blood-borne pathogens and highly transmittable infections, the increased cost of hospitalization and the threat of malpractice suits against surgeons make it imperative that all dental practitioners follow safe and sterile protocols and procedures that will reduce the likelihood of opportunistic infections.

Decontaminating the air

Air risk assessment measurements taken from dental surgeries have demonstrated concentrations of microorganisms in excess of five times that of outdoor air. There are four technologies available today that target the decontamination of air (Figure 3).

Filtration

Filtration or decontamination by filtration forces air through a HEPA filter (high efficiency particle arrestor). Used extensively in operating theatres and other highly sensitive medical environments, these filters have proved to be effective in reducing airborne contamination. In fact, the filters are capable of trapping particles as small as 0.3 microns – sufficient to prevent the majority of bacteria that measure between 0.1 and 10 microns, yet ineffective

Box 1. Bacteria that can be transmitted in the dental surgery

Mycobacterium tuberculosis
Staphylococcus aureus, including mrSA
Streptococcus pneumoniae
Haemophilus influenzae
Bordetella pertussis
Corynebacterium diphtheriae
Cytomegalovirus
Hepatitis b/C
Herpes simplex 1/2
HIV

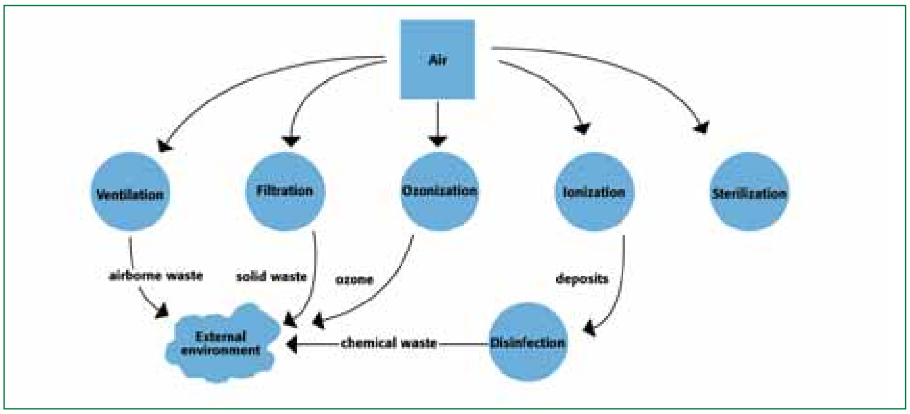

Figure 3: Processes for eliminating aerobiological pathogens.

against viruses that measure between 0.001 and 0.1 microns. Further, the pathogenic microorganisms remain in the filter thus attaching sensitivity and difficulty to the service and disposal processes.

Ozonization

Ozonisation subjects the air to high voltage charges. This results in the separation of adjacent oxygen atoms which thus brings about the creation of the ozone isotope (03). Ozone molecules are, however, highly reactive and when they come into contact with microorganisms they react, rendering them harmless. It has, however, been established that the dosage of ozone necessary to destroy microorganisms would, at the same time, be harmful to the health of human beings and to the environment, i.e. the amount of ozone required to destroy pathogens in the air would present a health risk to dental personnel and patients.

Ionization

Ionisation uses charged electrodes to project negative ions into the air; a process which occurs in nature when lightning accompanies a thunder storm. The microorganisms floating in the air attract these negatively charged ions, become heavier as a result and then precipitate on to surfaces. The microorganisms are not however destroyed via this process. They remain viable and thus require further treatment via some more conventional form of disinfection.

Sterilization

Only air sterilization assures the destruction of aerobiological microorganisms via a single process and without the creation of secondary harmful waste. When subjected to sustained ultraviolet irradiation – UVGI – the DNA of all bacteria and viruses are ruptured thus rendering them sterile and incapable of reproduction. In other words they are eliminated in a single pass through the air sterilization machine.

Conclusion

Bacteria and viruses that are capable of causing serious disease can be found in the mouth and saliva of people who might not show any symptoms. The chances of aerolization of blood and saliva during dental procedures is great, and is increased through the use of high-speed instruments. Processes for eliminating airborne pathogens include filtration, ionization, ozonization and sterilization and it is imperative that the dental team follow safe and sterile protocols to reduce the likelihood of opportunistic infections.

Key points

- The movement of bacteria and viruses in the air plays a significant role in the transmission of infection.
- Health and safety at work is an imperative within and throughout the dentistry sector.
- In dental surgeries exposure to aerobiological infection is exacerbated by the aerosolization of bacteria and viruses from patients' mouths, resulting from the use of high speed scaling, polishing and drilling equipment.
- Increasingly complex and critical procedures of a surgical nature, such as placing implants, are now being carried out regularly and in increasing number within UK dental practices. These require additional levels of infection control.
- Air sterilization via a new, stand-alone UV unit, is now available to protect dental practitioners, nurses and patients throughout the UK.

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